PATENT SPECIFICATION (11) 1 321 452

DRAWINGS ATTACHED

1 321 452

(21) Application Nos. 7907/70 (22) Filed 19 Feb. 1970
7908/70 19 Feb. 1970

(23) Complete Specification filed 19 April 1971

(44) Complete Specification published 27 June 1973

(51) International Classification F02B 47/10 F02M 25/06

(52) Index at acceptance
F1B 2A14B 2A15 2A1A 2A1C 2A1E 2A2B3 2A9A 2A9C 2G1F 2P12 2P1A4 2P1A5 2P2K2A 2P2K2B

(72) Inventors JOHN HAROLD WEAVING and CECIL DAVID HAYNES

(54) ATMOSPHERIC POLLUTION CONTROL ARRANGEMENT FOR INTERNAL COMBUSTION ENGINE

(71) We, BRITISH LEYLAND MOTOR CORPORATION LIMITED, a British Company, of Berkeley Square House, Berkeley Square, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to the exhaust gas

PATENTS ACT 1949

SPECIFICATION NO 1321452

The following corrections were allowed under Section 76 on 8 July 1974:-

Page 4, line 26, *after* 4, *delete* Figures 5 and 6 *after* Figure (3rd occurrence) *delete* 7 *insert* 5

THE PATENT OFFICE
5 August 1974

R 77524/1

oxides of nitrogen may be considerably reduced by the recirculation of a proportion of the exhaust gases into the engine via the inlet manifold, through which air or air and fuel are normally induced, in the cases of compression ignition and spark ignition engines respectively. This method of introducing exhaust gas causes a reduction in power and usually a deterioration in fuel consumption. It may also contaminate the carburettor in a spark ignition engine. An object of this invention is to reduce the proportions of oxides of nitrogen in exhaust gas coupled with the mitigation or elimination of these deleterious effects.

According to the invention, an internal combustion engine comprises at least one cylinder having an inlet valve arranged to close after bottom dead centre following the induction stroke of the engine, and an exhaust valve arranged to open before bottom dead centre during the power stroke of the engine, an additional valve also being provided which communicates with the cylinder and through which part of the gaseous products of combustion are removable before they have passed through the exhaust system of the engine to atmosphere, said additional valve being openable during the power stroke of the engine before the ex-

Conveniently the or each cylinder is associated with a receiver chamber for the part of the gaseous products of combustion removed through the additional valve, the latter also controlling the introduction of said part of the gaseous products into and out of the relevant receiver chamber. The or each receiver chamber may conveniently be formed in the head of the relevant cylinder.

In yet another arrangement for an engine comprising at least two cylinders each having said additional valve through which part of the gaseous products of combustion are removable before they have passed through the exhaust system of the engine, the engine includes duct means interconnecting the cylinders for re-introducing the gaseous products of combustion previously removed through the additional valve of one cylinder into the or another interconnected cylinder

[Price :

SEE CORRECTION SLIP ATTACHED

PATENT SPECIFICATION (11) 1 321 452

DRAWINGS ATTACHED

1 321 452

(21) Application Nos. 7907/70 (22) Filed 19 Feb. 1970
7908/70 19 Feb. 1970

(19)

(23) Complete Specification filed 19 April 1971

(44) Complete Specification published 27 June 1973

(51) International Classification F02B 47/10 F02M 25/06

(52) Index at acceptance
F1B 2A14B 2A15 2A1A 2A1C 2A1E 2A2B3 2A9A 2A9C 2G1F 2P12 2P1A4 2P1A5 2P2K2A 2P2K2B

(72) Inventors JOHN HAROLD WEAVING and CECIL DAVID HAYNES

(54) ATMOSPHERIC POLLUTION CONTROL ARRANGEMENT FOR INTERNAL COMBUSTION ENGINE

(71) We, BRITISH LEYLAND MOTOR CORPORATION LIMITED, a British Company, of Berkeley Square House, Berkeley Square, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to the exhaust gas emissions from internal combustion engines and in particular to the emission of oxides of nitrogen.

Due to the high temperature of combustion in the combustion chambers of internal combustion engines, both of the spark ignition and compression ignition types, oxides of nitrogen (principally nitric oxide) are formed by the combustion of nitrogen and oxygen from the air. Oxides of nitrogen are poisonous and the reduction of them in exhaust gases from internal combustion engines is the subject of legislation or proposed legislation in several countries.

It is well-known that the proportion of oxides of nitrogen may be considerably reduced by the recirculation of a proportion of the exhaust gases into the engine via the inlet manifold, through which air or air and fuel are normally induced, in the cases of compression ignition and spark ignition engines respectively. This method of introducing exhaust gas causes a reduction in power and usually a deterioration in fuel consumption. It may also contaminate the carburettor in a spark ignition engine. An object of this invention is to reduce the proportions of oxides of nitrogen in exhaust gas coupled with the mitigation or elimination of these deleterious effects.

According to the invention, an internal combustion engine comprises at least one cylinder having an inlet valve arranged to close after bottom dead centre following the induction stroke of the engine, and an exhaust valve arranged to open before bottom dead centre during the power stroke of the engine, an additional valve also being provided which communicates with the cylinder and through which part of the gaseous products of combustion are removable before they have passed through the exhaust system of the engine to atmosphere, said additional valve being openable during the power stroke of the engine before the exhaust valve opens and when the pressure in the cylinder is at least one atmosphere greater than atmospheric pressure whereby gaseous products of combustion will be removed through the additional valve, said additional valve being arranged to re-introduce under pressure the gaseous products of combustion previously removed through the additional valve into the or another cylinder substantially at the time the inlet valve closes, or shortly after closure of the inlet valve, whereby a lower combustion temperature will be obtained, thereby reducing the quantity of oxides of nitrogen in the gaseous products of combustion.

Conveniently the or each cylinder is associated with a receiver chamber for the part of the gaseous products of combustion removed through the additional valve, the latter also controlling the introduction of said part of the gaseous products into and out of the relevant receiver chamber. The or each receiver chamber may conveniently be formed in the head of the relevant cylinder.

In yet another arrangement for an engine comprising at least two cylinders each having said additional valve through which part of the gaseous products of combustion are removable before they have passed through the exhaust system of the engine, the engine includes duct means interconnecting the cylinders for re-introducing the gaseous products of combustion previously removed through the additional valve of one cylinder into the or another interconnected cylinder

[Price :

SEE CORRECTION SLIP ATTACHED

after closure of the inlet valve and before the next opening of the exhaust valve of said other cylinder and actuating means for opening and closing the additional valves in timed relationship to the opening and closing of the inlet and exhaust valves of the interconnected cylinders.

Conveniently in any of the foregoing arrangements, where the additional valve is provided in a cylinder, it may comprise a poppet valve arranged to be opened and closed by a cam-shaft. Where the inlet and exhaust valves of the cylinder or cylinders are also poppet valves operable by a cam-shaft or cam-shafts, a cam-shaft for controlling the opening and closing of inlet and/or exhaust valves may also be employed as or be interconnected with the cam-shaft for the additional poppet valve or valves.

Examples of several internal combustion engines in accordance with this invention are now described with reference to the accompanying drawings, in which:—

Figure 1 is a part end elevation of a cylinder block and part-axial section through the head portion of a cylinder thereof of a first engine;

Figure 2 is a diagrammatic view of the cylinder head on the line II—II in Figure 1;

Figure 3 is a typical timing diagram for a cylinder of the engine shown in Figures 1 and 2;

Figure 4 is an axial section through a head portion of a cylinder of a second engine generally similar to that shown in Figures 1 and 2 but having an alternative valve mechanism;

Figure 5 is a diagrammatic drawing showing end views of the cylinders of a third engine, each cylinder being generally similar to that shown in Figures 1 and 2.

The first internal combustion engine with which this invention is concerned is shown in Figures 1 and 2 and comprises one or more cylinders 1 each containing a piston 2 and having a head 3 defining seats 4, 5 for inlet and exhaust poppet valves of which one (the exhaust valve) is shown at 6 in Figure 1. The valves are opened and closed in known manner by an engine-driven cam shaft (not shown) through rocker arms of which one is shown at 7. The head 3 of each cylinder defines a combustion space 8 provided with a spark plug 12 and leading to a closed receiver chamber 9 via a third poppet valve 10 arranged to be opened and closed to admit gases into and out of the receiver chamber 9. The third poppet valve 10 is the aforesaid additional valve means. The third poppet valve is opened by a further cam shaft 11 engaging a cap 13 carried by the end of the shaft 14 of the valve 10 and is closed by means of a spring 15 acting between the cap 13 and a fixed valve housing 16. The cam shaft 11 is driven in timed relation to the main cam-shaft for opening and closing the inlet and exhaust valves. The opening and closing of the third valve 10 is so timed that it will open to the interior of the combustion space 8 and hence to the cylinder 1 for a short period commencing shortly before the opening of the exhaust valve 6 and ending before the exhaust valve 6 has closed, thereby to allow a part of the gaseous products of combustion in the cylinder to be discharged into the receiver chamber 9 instead of passing through the exhaust valve 6 to the exhaust system 17 of the engine. The third valve 10 is arranged to be closed before the exhaust valve 6 so that after the third valve 10 has closed the remainder of the gases exhausted from the cylinder 1 will pass to the exhaust system 17. The third valve 10 is arranged to be closed before the pressure in the cylinder 1 has dropped to atmospheric pressure, preferably when the pressure is between one and two atmospheres above atmospheric pressure. The third valve 10 is re-opened shortly before the inlet valve has closed the port 4 to permit the gaseous products of combustion in the receiver chamber 9 to be re-introduced into the cylinder. The third valve 10 is closed approximately 60° after the inlet valve has closed. In this way part of the gaseous products of combustion are re-introduced into the cylinder 1 without a reduction in the inlet charge. Figure 3 is a typical timing diagram in which the annular positions at which the exhaust valve 6 opens and closes are indicated at A and B, the positions of opening and closing of the third valve 10 in timed relation to the opening and closing of the exhaust valve 6 are indicated at C and D. As will be seen, the opening at C of the third valve 10 occurs before the opening at A of the exhaust valve 6. The third valve 10 closes at D shortly after the exhaust valve 6 opens. Between positions C and A, the third valve 10 only is open, and during that time the gaseous products of combustion will flow only to the receiver chamber 9. During the time between positions A and D the gaseous products of combustion will flow partly through the third valve 10 to the receiver chamber 9 and partly to the exhaust ssytem 17 of the engine. During the time between positions D and B, the third valve 10 is closed and therefore the whole of the gases leaving the cylinder 1 will flow through the exhaust system 17 of the engine. The positions of opening and closing of the inner valve are indicated at E and F respectively and the positions of opening and closing of the third valve 10 are indicated at G and H respectively. As will be seen, for most of the period during which the third valve 10 is

open the inlet valve is closed. The positions of opening and closing, indicated at A to H of the three valves are typical positions shown by way of example only. The configuration of the combustion space 8 and the receiver chamber 9 is that adopted in an experimental engine and may be of other form in a production engine.

Figure 4 shows an alternative engine in which a third or additional poppet valve 20, similar to the valve 10 in Figure 1, is arranged to be opened and closed by means of a rocker arm 21 and return spring 22 from the same cam shaft 23 used to operate the inlet and exhaust valves of the engine. One of the latter valves is shown at 24. The receiver chamber, similar to 9 in Figure 1, is shown at 25 and communicates with the combustion space 26 above the piston 27 when the valve 20 is open.

A six-cylinder, four stroke cycle engine, each having inlet and exhaust poppet valves arranged to be interconnected is indicated in Figure 5 which shows diagrammatically end views of the six cylinders.

Each cylinder 61, 62, 63, 64, 65 and 66 has an inlet valve 70, an exhaust valve 71 and the additional or third poppet valve 72 and is generally similar to the cylinder illustrated in Figures 1 and 2. The seats of the additional or third poppet valves 72 of cylinders Nos. 61, 62 and 63 are interconnected by a first manifold 73 and the seats of the additional or third poppet valves 72 of cylinders Nos. 64, 65 and 66 are interconnected by a second manifold 74. The valves 72 are arranged to be opened and closed by a cam-shaft similar to that shown at 11 in Figure 1 or 23 in Figure 4 and their opening and closing is so timed that the cylinders will be interconnected in pairs through either the manifold 73 or the manifold 74. In a six-cylinder engine having a conventional firing order 1, 5, 3, 6, 2, 4, the cylinders are interconnected in pairs in the following sequence:—61 and 63, 65 and 66, 63 and 62, 66 and 64, and 62 and 61. Other timing arrangements can be provided for engines having different firing orders or different numbers of cylinders.

The opening and closing of the poppet valves 72 are also so timed in relation to the timing of the opening and closing of the inlet and exhaust valves 70 and 71 of the relevant cylinders that the additional or third valve 72 of one cylinder of an interconnected pair will be opened before and during part of the time the exhaust valve of that cylinder is open, whereby part of the gaseous products of combustion will be removed from the said one cylinder to be reintroduced through the manifold 73 or 74 into the other cylinder of the interconnected pair instead of passing through the exhaust valve of the said one cylinder to the exhaust system of the engine. In this way there will be pressure in the manifold 73 or 74 at the time the valve 71 is opened. The additional or third valve 72 of the other cylinder of the pair is timed to be opened to the said other cylinder at the time the inlet valve 70 thereof closes or shortly after it has closed. In this way the exhaust gases diverted from one cylinder through the manifold 73 or 74 are introduced into the other cylinder of an interconnected pair without affecting the inlet charge to said other cylinder.

WHAT WE CLAIM IS:—

1. An internal combustion engine comprising at least one cylinder having an inlet valve arranged to close after bottom dead centre following the induction stroke of the engine, and an exhaust valve arranged to open before bottom dead centre during the power stroke of the engine, an additional valve also being provided which communicates with the cylinder and through which part of the gaseous products of combustion are removable before they have passed through the exhaust system of the engine to atmosphere, said additional valve being openable during the power stroke of the engine before the exhaust valve opens and when the pressure in the one cylinder is at least one atmosphere greater than atmospheric pressure whereby gaseous products of combustion will be removed through the additional valve, said additional valve being arranged to re-introduce under pressure the gaseous products of combustion previously removed through the additional valve into the or another cylinder substantially at the time the inlet valve closes, or shortly after closure of the inlet valve, whereby a lower combustion temperature will be obtained, thereby reducing the quantity of oxides of nitrogen in the gaseous products of combustion.

2. An engine as claimed in Claim 1 in which the or each cylinder is associated with a receiver chamber for the part of the gaseous products of combustion removed through the additional valve, the latter also controlling the introduction of said part of the gaseous products into and out of the relevant receiver chamber.

3. An engine as claimed in Claim 2 in which said receiver chamber is formed in the head of the relevant cylinder.

4. An engine as claimed in Claim 1 and comprising at least two cylinders each having said additional valve through which part of the gaseous products of combustion are removable before they have passed through the exhaust system of the engine, the engine also including duct means interconnecting the cylinders for re-introducing the gaseous products of combustion previously removed

through the additional valve of one cylinder into the or another interconnected cylinder after closure of the inlet valve and before the next opening of the exhaust valve of said other cylinder and actuating means for opening and closing the additional valves in timed relationship to the opening and closing of the inlet and exhaust valves of the interconnected cylinders.

5. An engine as claimed in any preceding claim in which said additional valve comprises a poppet valve and a cam-shaft for opening and closing said poppet valve.

6. An engine as claimed in Claim 5 having a cam-shaft for controlling the opening and closing of inlet or exhaust valves or both inlet and exhaust valves of the engine in which the latter cam-shaft is also employed as or is interconnected with the cam-shaft for opening and closing the poppet valve comprising said additional valve.

7. An internal combustion engine constructed and arranged substantially as described herein with reference to Figures 1 to 3, Figure 4, Figures 5 and 6 or Figure 7 of the accompanying drawings.

WALFORD & HARDMAN BROWN,
Chartered Patent Agents,
Trinity House,
Hales Street,
Coventry, Warwickshire.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1973.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

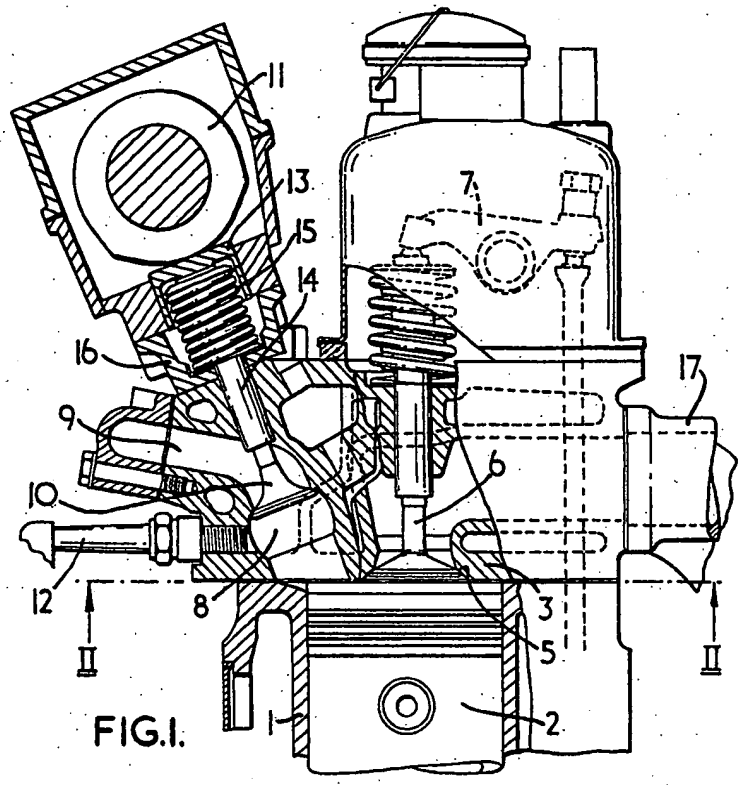

FIG.1.

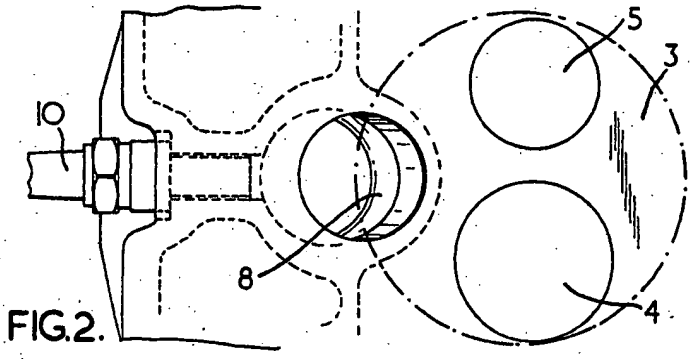

FIG.2.

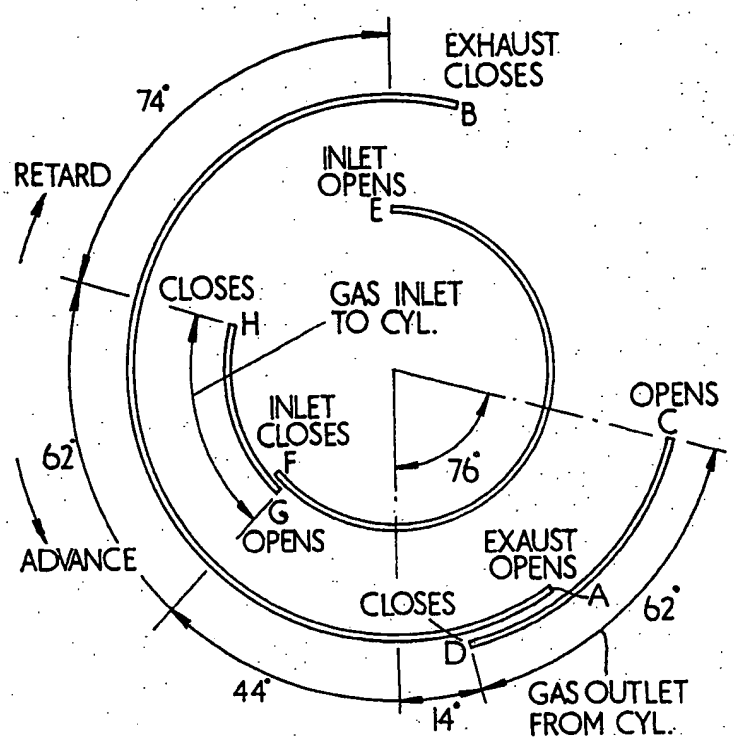
EXHAUST CLOSES
B
74°
RETARD
INLET OPENS
E
CLOSES
H
GAS INLET TO CYL.
INLET CLOSES
F
OPENS
C
62°
76°
G
OPENS
ADVANCE
EXAUST OPENS
A
CLOSES
62°
D
44°
14°
GAS OUTLET FROM CYL.

FIG. 3.

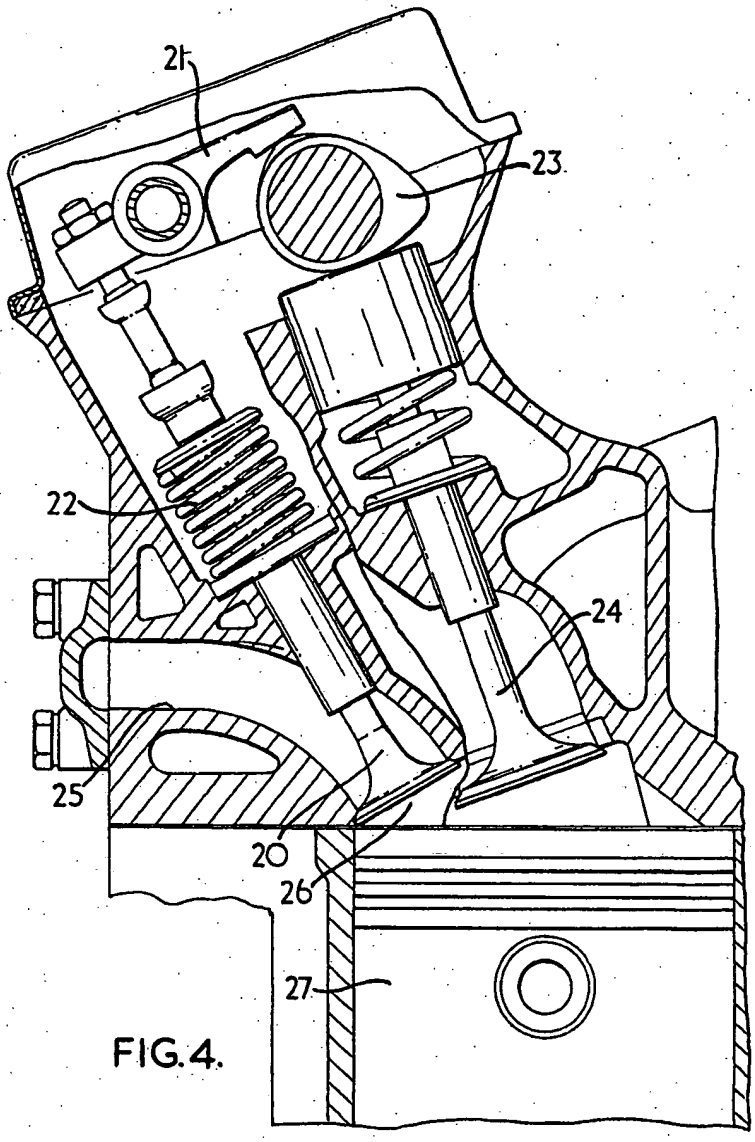

FIG.4.

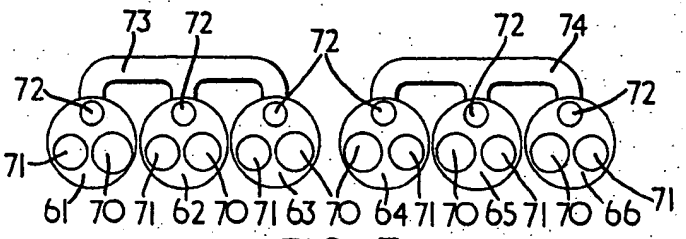

FIG. 5